*भारतीय मानक* **IS 1121 (Part 2) : 2023**

***Indian Standard***

# प्राकृतिक इमारती पत्थर के सामर्थ्य गुणों को ज्ञात करना — परीक्षण पद्धतियाँ

## भाग 2 अनुप्रस्थ क्षमता

*( तीसरा पुनरीक्षण )*

# Determination of Strength Properties of Natural Building Stones — Methods of Test

## Part 2 Transverse Strength

*( Third Revision )*

ICS 91.100.15



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**November 2023** **Price Group 5**

FOREWORD

This Indian Standard (Part 2) (Third Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Stones Sectional Committee had been approved by the Civil Engineering Division Council.

Building stones are available in large quantity in various parts of the country and to choose and utilize them for their satisfactory performance, it is necessary to know the various strength properties determined according to standard procedure. This standard has therefore been formulated to cover the standard method for determining the strength properties of various stones. This standard covering compressive, transverse and shear strength properties was published in 1957 and was subsequently revised in 1974 and in 2013.

In the previous revision of the standard, the property of tensile strength was also added as the same was important for assessing the suitability of stone. Surface finishing requirement of specimen was also modified, vacuum saturation was specified for conditioning of the test specimens in place of normal immersion, rate of conditioning was modified, etc. The revision in 1974 was issued in four parts; other parts being:

Part 1 Uniaxial compressive strength
Part 3 Indirect tensile strength
Part 4 Shear strength

All four parts of IS 1121 are being revised. In doing so, another part namely, Part 5 'Flexural modulus of elasticity' is being introduced.

The major changes incorporated in this revision are as follows:

a) The specimen size has been modified;
b) The apparatus as well as the test procedure has been modified;
c) The formula for finding the flexural strength has also been modified accordingly; and
d) A sample test report has been provided for reference.

This standard contributes to the United Nations Sustainable Development Goal 11 'Sustainable cities and communities' towards strengthening the efforts to protect and safeguard the world's cultural and natural heritage.

The composition of the Committee responsible for formulation of this standard is given in Annex B.

In reporting the results of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 2022 'Rules for rounding off numerical values (*second revision*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Indian Standard*

# DETERMINATION OF STRENGTH PROPERTIES OF NATURAL BUILDING STONES — METHODS OF TEST

## PART 2 TRANSVERSE STRENGTH

*( Third Revision )*

### 1 SCOPE

This standard (Part 2) lays down the procedure for determination of transverse strength of natural building stones used for constructional purposes.

### 2 REFERENCE

The standard given below contains provision, which through reference in this text, constitutes provision of this standard. At the time of publication, the edition indicated was valid. All standards are subject to revision and parties to agreements based on this standard is encouraged to investigate the possibility of applying the most recent edition of this standard:

| *IS No.* | *Title* |
|---|---|
| IS 9179 : 1979 | Method for preparation of rock specimen for laboratory testing |

### 3 SELECTION OF SAMPLES

**3.1** The sample shall be selected to represent a true average of the type or grade of stone under consideration.

**3.2** The sample shall be selected from the quarried stone or taken from the natural rock, as described in **3.2.1** and **3.2.2** and shall be of adequate size to permit the preparation of the requisite number of test specimens.

NOTE — The sample size, if cuboidal shall not be less than 30 cm side; and if drilled, shall not be less than 15 cm length

#### 3.2.1 Stones from Ledges or Quarries

The ledge or quarry face of the stone shall be inspected to determine any variation in different strata. Differences in colour, texture and structure shall be observed for sampling purpose. Separate samples of stone of adequate size of the unweathered specimens shall be obtained from all strata that appear to vary in colour, texture and structure. Specimens that have been damaged by blasting, driving wedges, heating, etc, shall not be included in the sample.

#### 3.2.2 *Field Stone and Boulders*

The different kinds of stones and their conditions at the quarry site shall be recorded (like the degree of weathering, water seepage zones if any, etc). Separate samples for each class of stone that would be considered for use in construction as indicated by visual inspection shall be selected.

**3.3** When perceptible variations occur in the quality of rock, as many samples as are necessary for determining the range in properties shall be selected.

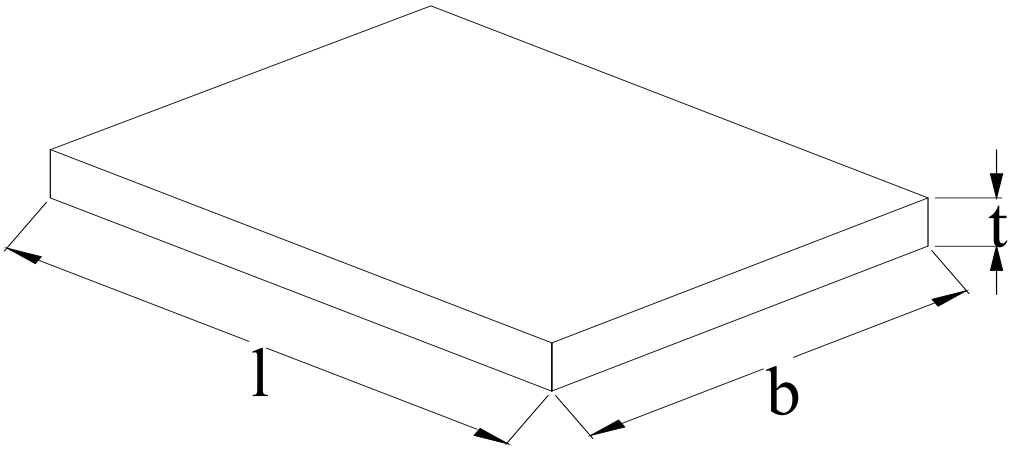
### 4 TEST SPECIMENS AND CONDITIONING

**4.1** Test specimens shall be made from samples selected in accordance with **3** and shall be block/prism of size 350 mm × 100 mm × 30 mm. The test specimens shall be measured at the broken section. The width and thickness shall be measured to the nearest 0.2 mm at mid of the broken section.

**4.2** In cases where it may be required to test the sample at job thickness, width of the specimen shall be 1.5 times the depth of the sample subject to minimum of 100 mm and length shall be 10 times the sample thickness + 50 mm (*see* Fig. 1).

NOTES

**1** The values obtained on non-standard specimens as per **4.2** shall not be compared with the values measured in standard size specimens as per **4.1**.
**2** Job thickness is the actual thickness of the stone which will be used by the client.




where

$l$ = 10t + 50 mm (*Max* 350 mm);
b = 1.5t (*Min* 100 mm); and
t = 30 mm or actual job thickness; whichever is less.

FIG. 1 SAMPLE SIZE

**4.3** The load-bearing surfaces shall be prepared in accordance with IS 9179.

**4.4** The specimen shall have direction of the plane of anisotropy (that is, joints, foliation, cleavage, rift, bedding etc) perpendicular to the plane of loading.

**4.5** Five test specimens shall be used for conducting the test in each of the conditions mentioned in **4.5.1** and **4.5.2** separately.

**4.5.1** The test specimens shall be saturated by vacuum saturation by immersing in water maintained at 20 °C to 30 °C in an evacuation vessel under a vacuum of about 50 mm of Hg to 100 mm of Hg. Specimens shall be initially immersed continuously for about 4 h to 5 h in vacuum and then its mass measured at an interval of 1 h (sample being replaced back in evacuation vessel after weighing) till constant mass. Constant mass is considered to have been achieved when two consecutive measurement of mass do not vary by more than 0.1 percent of the saturated mass. Vacuum may be created by a suitable air suction pump.

**4.5.2** The test specimens shall also be tested in a dry condition and shall be dried in an oven at 70 °C ± 5 °C for 48 h, subsequent to which, hourly mass measurements shall be made. Constant mass is considered to have been achieved when two consecutive measurements of mass do not vary by more than 0.1 percent. These hourly measurements may be made in the hot condition also taking necessary precautions while handling. Upon obtaining the constant mass, the specimen shall be cooled in a desiccator to room temperature (20 °C to 30 °C) and the final mass shall be recorded.

## 5 APPARATUS

A suitable arrangement of loading and supporting sample is shown in Fig. 2.

## 6 PROCEDURE

**6.1** Each test specimen to be tested shall be evenly supported upon two self-aligning bearers (2 and 3 in Fig. 2) 40 mm in diameter, the distance between the centres of bearers being 300 mm. The bearing surfaces of the supporting and loading rollers shall be wiped clean, and any loose sand or other material removed from the surfaces of the specimen where they are to make contact with the rollers. The specimen shall then be placed in the machine in such a manner that the load shall be applied to the uppermost surface as cast in the mould. The load shall not be applied until all loading and supporting rollers are resting evenly against the test specimen.

**6.2** The load shall then be applied centrally on top surface at a distance L/3 from each support with a uniform rate of 4 MPa/min (20 N/s for standard specimen size as **4.1**) through the loading bearers (1 in Fig. 2), upon the upper surface of the specimen (*see* Fig. 2) and parallel to the supports till failure and maximum load applied shall be recorded nearest to 0.1 kN. The length of all bearers shall exceed the maximum width of the specimen to be tested. Measurement of width and depth shall be recorded at mid-way of broken section nearest to 0.1 mm.

**6.3** If the point of failure falls outside the point of loading towards the supports beyond the middle L/3, the results of the tests shall be discarded and additional sample shall be tested.

## 7 EVALUATION AND REPORT OF TEST RESULTS

**7.1** The transverse strength of the specimen tested shall be calculated as follows:

$$R = \frac{WL}{bt^2}$$

where

$R$ = transverse strength, in N/mm$^2$;
$W$ = central breaking load, in N;
$L$ = length of span, in mm;
$b$ = width in mm of the test specimen at the section of failure; and
$t$ = depth in mm of the test specimen at the section of failure.

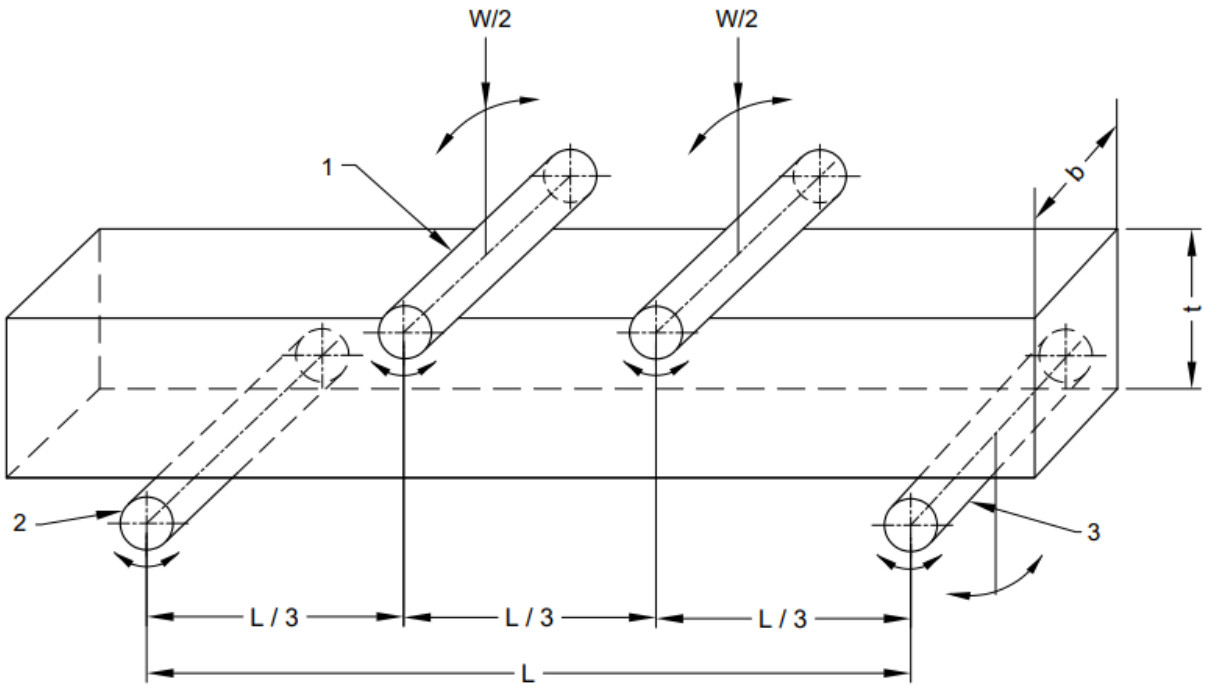
**7.2** The individual and average of all the five results (separately for saturated and dry condition) shall be taken for the purpose of determining transverse strength of the sample.

**7.3** The individual and average of the five valid test results in each condition separately (*see* **4.4**) shall be taken for purposes of reporting the transverse strength of the sample having individual variation not more than ± 15 percent of the average result. Additional samples shall be tested to replace the invalid test result.

**7.4** The transverse strength of the sample shall be expressed in N/mm$^2$ and shall be reported to 3 significant figures.

**7.5** Identification of the sample, date when the sample was taken and type of stone shall be reported.

**7.6** The size and shape of the test specimen used in the test shall be indicated. A sample format of test report is attached at Annex A.




KEY
1. LOADING ROLLER ( CAPABLE OF ROTATION AND BEING INCLINED )
2. SUPPORTING ROLLER
3. SUPPORTING ROLLER ( CAPABLE OF ROTATION AND BEING INCLINED )

FIG. 2 APPARATUS FOR DETERMINATION OF TRANSVERSE STRENGTH

## ANNEX A

(*Clause* 7.6)

## SAMPLE FORMAT FOR OBSERVATION SHEET FOR TRANSVERSE STRENGTH TEST OF STONES

Inward No.: Sample No.: Date:

Sample pre-treatment for saturated conditions:

| Sub sample No. | Mass of sample in saturated surface wet condition | | | | Final mass in SSD condition |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | |
| 01 | | | | | |
| 02 | | | | | |
| 05 | | | | | |

Sample pre-treatment for dry conditions:

| Sub sample No. | Mass of sample in hot condition | | | | Final mass after cooling |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | |
| 06 | | | | | |
| 07 | | | | | |
| 10 | | | | | |

Test in dry/wet condition for load applied perpendicular to the plane of foliation, cleavage, rift or bedding.

Span between the support (L) : _____ mm

| Sub sample No. | Width at failure section (b) | Depth at failure section (d) | Central breaking load in N ($W$) | Transverse strength (R) in $N/mm^2$ $WL/bd^2$ | Validity * of result Yes/No | Average transverse strength of 5 valid results under each conditioning |
|---|---|---|---|---|---|---|
| 01 | | | | | | |
| 02 | | | | | | |
| 10 | | | | | | |
| * Valid results are those which falls within average of 5 results ± 15 percent. | | | | | | |

**ANNEX B**

(*Foreword*)

**COMMITTEE COMPOSITON**

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Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the website-www.bis.gov.in or www.standardsbis.in.

This Indian Standard has been developed from Doc No.: CED 06 (21961).

## Amendments Issued Since Publication

| Amend No. | Date of Issue | Text Affected |
|---|---|---|
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Published by BIS, New Delhi